



ADVANCED MATERIAL SOLUTIONS FOR LI-ION BATTERY APPLICATIONS

*Innovative Materials built from
Decades of Automotive Expertise*



ABOUT DOW

Corporate Stats¹

2018 Pro Forma Net Sales of **\$49.7B**

113 manufacturing sites in **31** countries

Serving customers in **~160** countries



OUR AMBITION

To become the most innovative, customer-centric, inclusive and sustainable materials company in the world

OUR GOAL

Profitable growth & best-in-class performance

OUR CORE VALUES

Integrity
Respect for people
Protecting our planet



STREAMLINED AND FOCUSED PORTFOLIO

RE-ALIGNED BUSINESSES

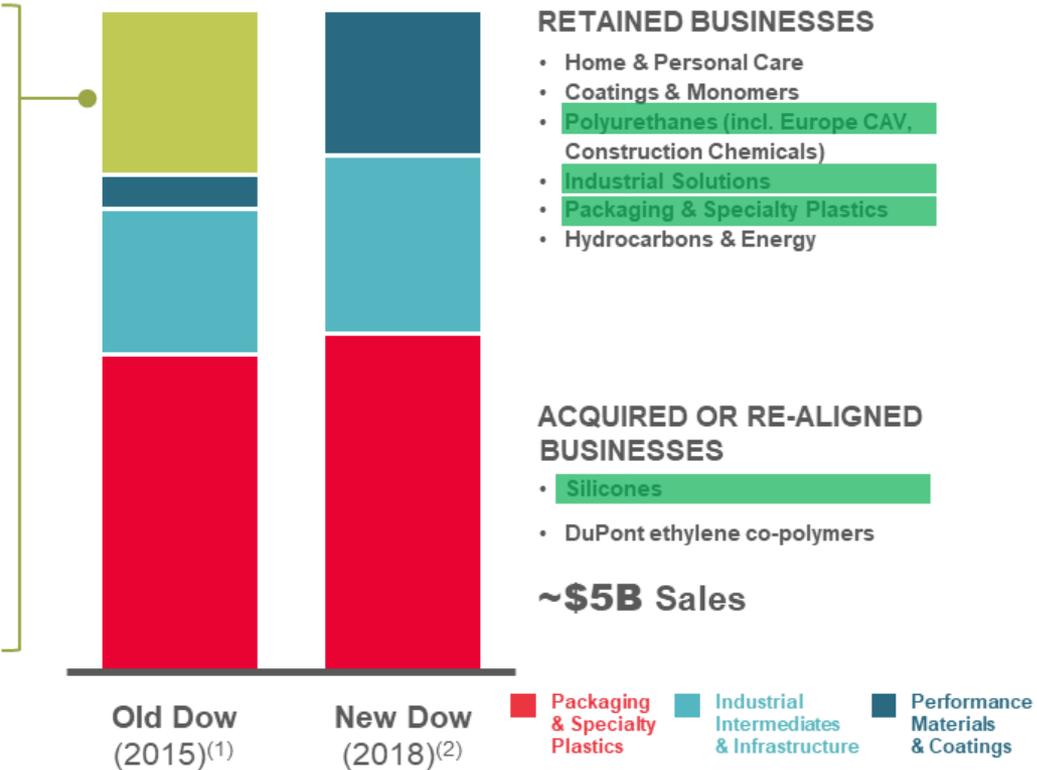
- Ag
- Electronic Materials
- Water
- Microbial Control
- Food & Pharma
- Auto Adhesives
- Building Solutions
- Silicones (aligned with SpecCo market verticals)
- Hemlock JV

>\$12B Sales

DIVESTED BUSINESSES

- Chlor-Alkali (Americas)
- Epoxy
- Chlorinated Organics
- Angus Chemical
- Sodium Borohydride
- AgroFresh

~\$2B Sales



Dow has a strong portfolio to support e-mobility



DOW: INNOVATION THAT DRIVES COMMERCIAL VALUE

BUILDING BLOCKS

Advanced Back-Integration



Acrylics



Propylene Oxide



Ethylene Oxide



Polyolefins and Elastomers



Silicones

CAPABILITIES

World-Class Science and Engineering Capabilities



High-Throughput Research



Catalyst Discovery & Ligand Synthesis



Polymer Science



Materials Science



Formulation Expertise



Process Engineering



High-Performance Computer Modeling



Application Development



Product Safety

SOLUTIONS

Narrower, Deeper End-Market Presence



Packaging



Infrastructure



Consumer Care

Advanced Material Solutions for Battery

CHALLENGES

- Safety & reliability
- Energy density
- Thermal management
- Cost effectiveness

SOLUTIONS

Encapsulants

Light weight, cables protection, dielectric encapsulation and vibration absorption

Thermally conductive gap filler

High thermal conductivity, low density, low thermal resistance and enhanced elongation

CFRP housing

Fast Processing, Lightweight

Foam

Fire protection and vibration absorbing thermal insulation foam

Conformal Coatings

Waterproof, Dustproof, Anti-static

Coolant fluid

Improved battery pack heat dissipation

Cell Cushion in Battery Pack

Space release and Vibrations dampen

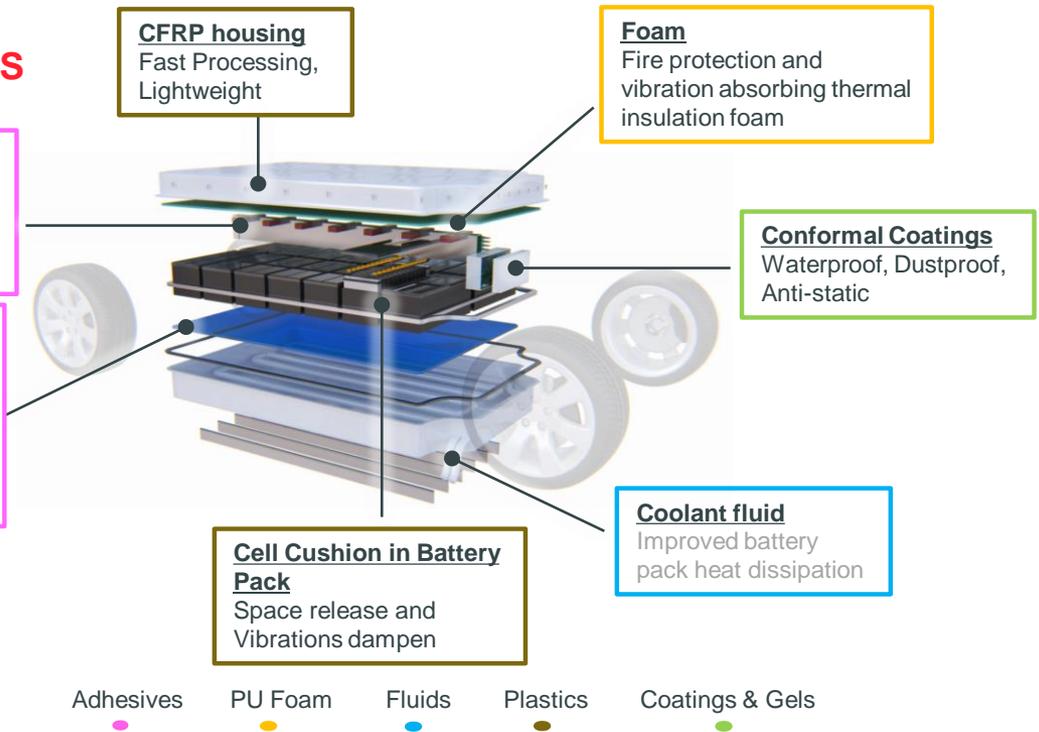
Adhesives

PU Foam

Fluids

Plastics

Coatings & Gels



NORDEL® EPDM Cushion



APPLICATION

- EPDM for space release and vibrations dampen between cells in battery pack

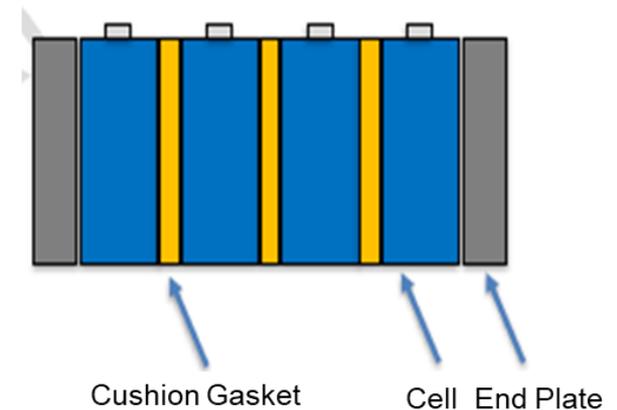
TECHNOLOGY & ADVANTAGE

- **NORDEL® EPDM based cushion gasket**
 - ✓ Low hardness & low compressive modulus
 - ✓ Excellent mechanical strength
 - ✓ Adjustable flame resistance: UL94 HB to UL94 V0
 - ✓ Outstanding water and moisture resistance
 - ✓ Broad service temperature : -40 °C to 150 °C

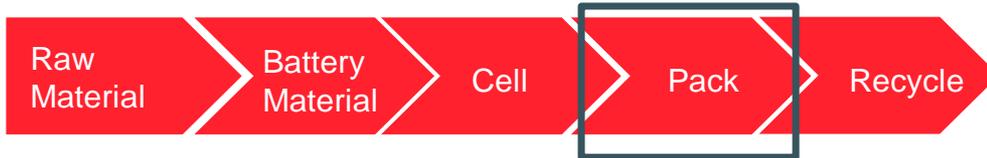
BENEFITS

- Lower cost with balanced performance
- Safer battery pack

Battery Cushion Gasket



Lightweight Composite



APPLICATION

- Composite to replace current Al case of battery pack

TECHNOLOGY & ADVANTAGE

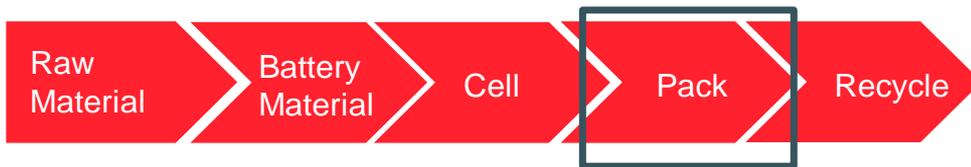
- **PCM (Prepreg compound molding)**
 - ✓ High mechanical strength
 - ✓ Good de-moulding performance
 - ✓ Long storage time at RT
 - ✓ UL94V0
- **HPRTM (High pressure resin transfer molding)**
 - ✓ High productivity within 3-5min curing
 - ✓ Low production cost
 - ✓ High mechanical strength
 - ✓ UL94 V0

BENEFITS

- Lightweight, mass reduced up to 40%
- Flexibility of design
- Higher pack energy density



Silicone Gap Filler



APPLICATION

- Thermal gap filler to replace thermal pad between battery module and bottom box

TECHNOLOGY & ADVANTAGE

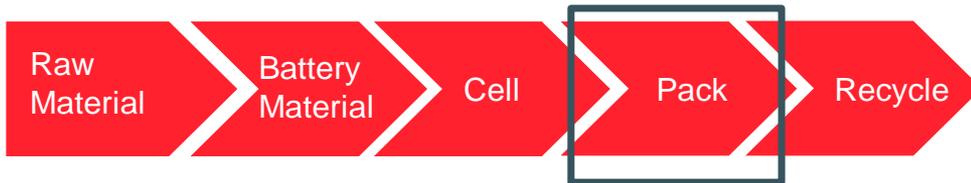
- **2 parts silicone gap filler**
 - ✓ Low modulus
 - ✓ Low density
 - ✓ Extremely low thermal resistance
 - ✓ Good flame retardant property(UL-94 V0)

BENEFITS

- Ease for automation
- Lightweight and higher energy density
- Low total cost in use



Conformal Coating



APPLICATION

- Thin protective film / breathing membrane that filters water vapor & solid debris in BMS

TECHNOLOGY & ADVANTAGE

- **Silicone conformal coating**
 - ✓ Stress relieving and good protection
 - ✓ Good performance between -45°C to 200°C
 - ✓ Protects insulation resistance
 - ✓ Reduces conductor spacing on PCBs
 - ✓ Good dielectric properties (insulation, moisture resistance, breakdown voltage)

BENEFITS

- Long term reliability
- Process design feasibility



Silicone Foam



APPLICATION

- Silicone Gasket for EV battery Pack Sealing

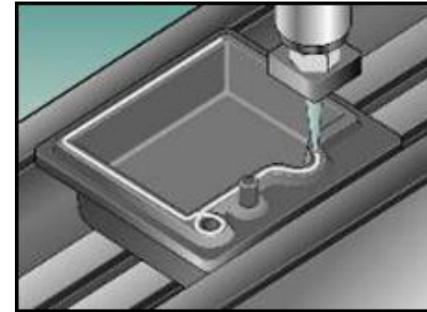
TECHNOLOGY & ADVANTAGE

Silicone Foam as Gasket

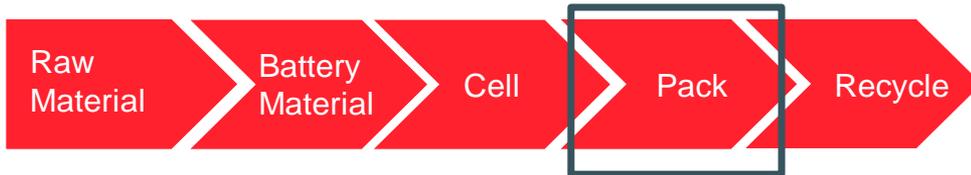
- ✓ Broad silicone gasket solution with proved performance
FIPG (Formed In Place Gasket); CIPG (Cured In Placed Gasket);
DFG (Dispensed Foam Gasket)
- ✓ Fit for automatic production
- ✓ Excellent reliability after aging

BENEFITS

- Industrial 4.0, Improved production efficiency
- Low total cost in use



Potting Materials



APPLICATION

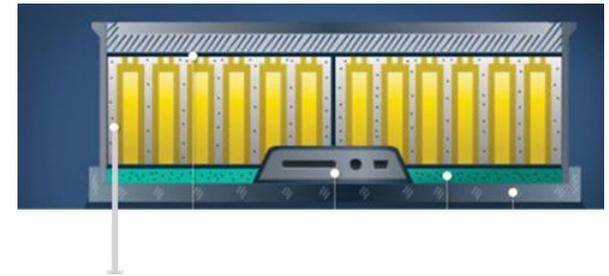
- Differentiated silicone-organic pottant solution for battery protection

TECHNOLOGY & ADVANTAGE

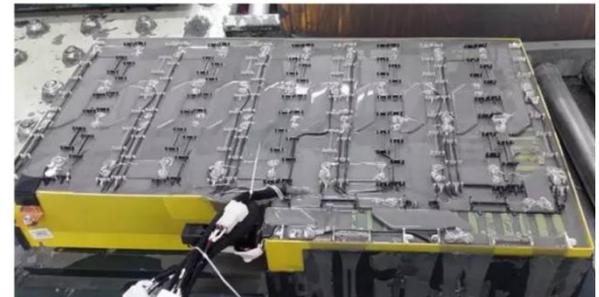
- **Silicone or Si-organic pottant**
 - ✓ Balance of performance and cost
 - ✓ Low stress and modulus
 - ✓ Non-toxic and no odor
 - ✓ Good performance between -45°C to 150°C

BENEFITS

- Lower cost with balanced performance
- Safer battery pack



Pottant Materials



Coolant Fluid



APPLICATION

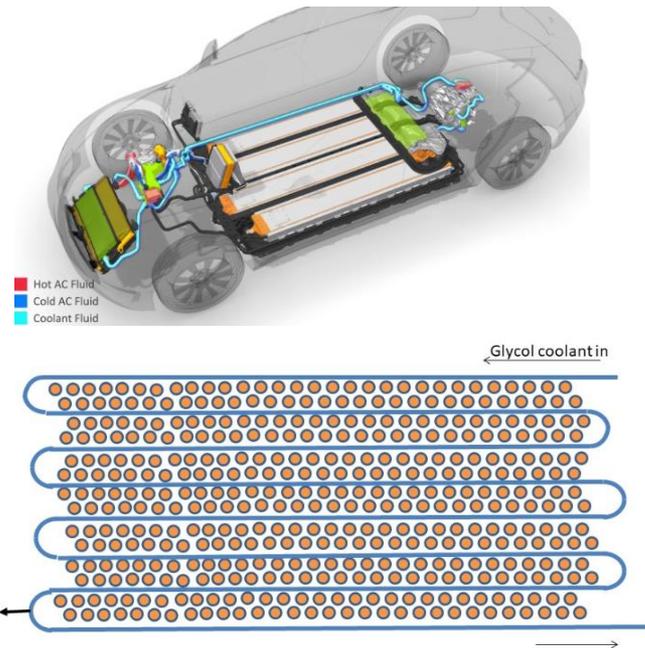
- Unique inhibitory glycol for cooling of whole battery pack

TECHNOLOGY & ADVANTAGE

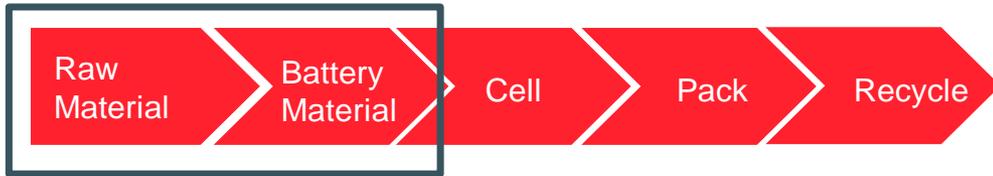
- **Glycol coolant**
 - ✓ Customize for power battery
 - ✓ Excellent cooling performance
 - ✓ Wide temperature working window
 - ✓ No scale generated

BENEFITS

- Long term reliability
- Safer battery pack



Dispersant & Rheology Modifier for Ceramic Coating on Separator



APPLICATION

- Dispersant & Rheology for Ceramic Coating on Separator

TECHNOLOGY & ADVANTAGE

Dispersant

- ✓ High dispersing efficiency
- ✓ Low metal ion content
- ✓ Hydrophobic dispersant for low water residual in ceramic coating
- ✓ Maintain viscosity during ceramic slurry storage
- ✓ Compatible with other additives and binders

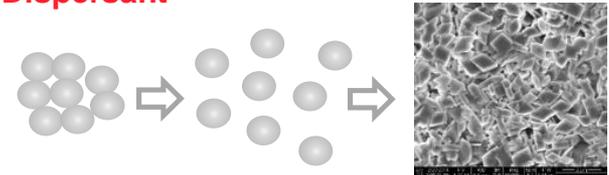
Rheology modifier

- ✓ High thickening efficiency
- ✓ Excellent association with binder for uniform ceramic coating
- ✓ Hydrophobic modified for low water residual in ceramic coating
- ✓ Meet different processing: leveling, mixing and high speed coating

BENEFITS

- Short cycle time
- Uniform performance
- Flexible process choices

Dispersant



Agglomerated ceramic particles

Dispersed by Dow additive

Ceramic coating on separator

Rheology modifiers

Process	Shear Rate							
	10^{-2}	10^{-1}	10^0	10^1	10^2	10^3	10^4	10^5
Levelling	█	█						
Dip coat			█	█	█			
Pumping			█	█	█	█		
Mixing				█	█	█		
Dispersing					█	█	█	
Spray coat						█	█	█
Roller coat						█	█	█
Blade coat						█	█	█





Seek

Together™